LUMMI CONTINUOUS DATA MANAGEMENT SYSTEM (LCDMS) DOCUMENTATION

v. 1.0

Updated 12/6/2010

December 2010

LUMMI CONTINUOUS DATA MANAGEMENT SYSTEM (LCDMS) DOCUMENTATION

Prepared For:

Lummi Indian Business Council

(LIBC)

Funded By:

Environmental Protection Agency

Assistance Identification No. BG-97042601-3

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December 2010

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1 Introduction

The Lummi Water Resources Division operates an extensive water quality-monitoring program for both surface water and ground water sites across the Lummi Reservation. Data management logistics, and federally mandated reporting requirements, have meant that data storage and retrieval has become too complex for the spreadsheet software that had been used historically. Instead, a custom Access database application (The Lummi Water Quality Monitoring Database) was developed to store discretely measured water quality observations collected by the Water Resources Division. However, the Lummi Water Quality Monitoring Database application was not designed to handle continuously measured data from sources, such as data loggers recording water levels in wells or meteorological data associated with weather stations. Such data is incompatible with the existing database primarily because the existing table structure requires that conceptual events, such as discrete sampling 'runs' and 'sitevisits', be explicitly recorded as required attributes alongside the data values and these events are meaningless in the context of data collected continuously over extended periods of time. Consequently, a complementary database application, the Lummi Continuous Data Management System (LCDMS), has subsequently been developed to assist with data management specifically for continuous datasets.

The purpose of this document is to guide users of the LCDMS through the various steps of importing, exporting, summarizing, and analyzing continuous data.

Any questions or issues not addressed by this document may be referred to Craig Dolphin at Lummi Natural Resources (360 384-2387), or Jeremy Freimund at Lummi Water Resources (360 384-2212).

2 Table Structure

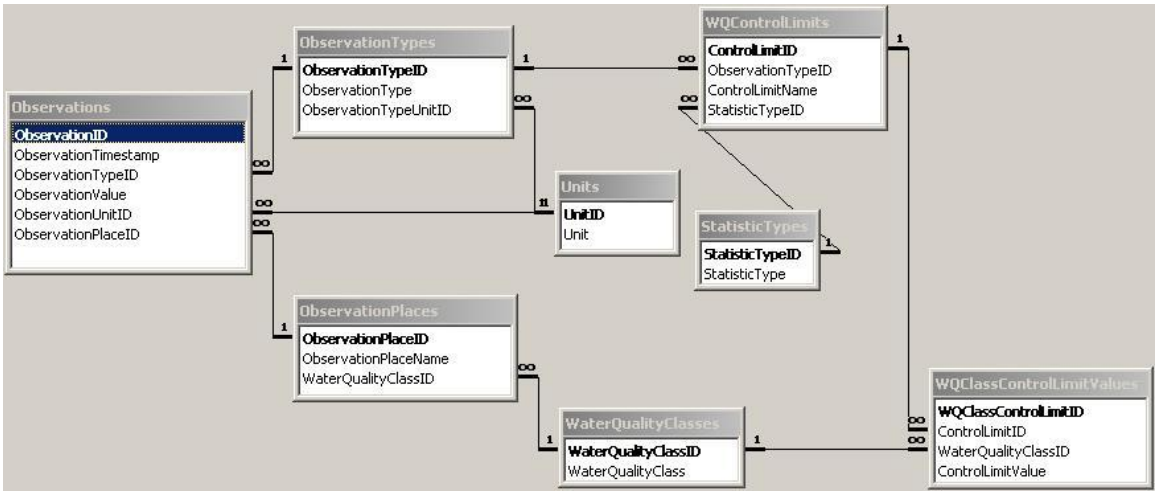


Figure 2.1. Entity Relationship Diagram showing the primary tables and relationships used by the LCDMS database

2.1 Main Tables

The LCDMS stores information relating to various environmental parameters that are measured continuously over an extended period of time and stored in data-loggers. In order to prevent excessive use of file space, the frequency of observations stored in the database is not intended to be more frequent that one observation every fifteen minutes. However, in some cases, the frequency of observations might be less frequent. In particular, temperature data sourced from online telemetry and stored in this database may actually be pre-processed and the values stored represent daily averages rather than a series of individual measurements.

2.1.1 Observations

Table *Observations* stores individual data values and associated metadata, including the date and time of the observation, the identifier for the type of observation being measured (e.g., salinity, water level), the identifier for the location that the measurement was recorded from, and the identifier for the unit

of measurement being used (e.g., ppt, feet). All measurement values must be numerical: no text values can be accepted.

2.1.2 ObservationTypes

Table *ObservationTypes* stores a list of measurement types that can be stored in the database (e.g., water temperature) and the identifier for the default unit (e.g., degrees Celcius) to be used when storing imported measurements of that type.

2.1.3 ObservationPlaces

Table *ObservationPlaces* stores a list of the locations where continuous data has been collected and stored in the database. Each location also has an identifier for the water quality classification that applies to that location.

2.1.4 WaterQualityClasses

Table *WaterQualityClasses* stores the list of classifications used to categorize locations where data is collected.

2.1.5 WQControlLimits

Table *WQControlLimits* stores a list of named control limits that can be used to determine whether observed values at a site are within an acceptable range, or not. Each control limit value applies to a summary statistic (e.g., mean, maximum, minimum) for the relevant parameter (e.g., temperature) as calculated for a particular interval of time (e.g., 7 days, monthly). Each control limit is named using a convention that refers to the summary time interval, the statistic, and the parameter of interest (e.g., 7-Day Max Temperature Limit).

2.1.6 WQClassControlLimitValues

Table *WQClassControlLimitValues* stores the list of control limits and limit values that apply to sites that have been designated with a particular water quality classification.

2.1.7 StatisticTypes

Table *StatisticTypes* stores the list of summary statistics (e.g., mean, maximum, etc) that are available for use by the database.

2.1.8 Units

Table *Units* stores the list of units of measurement that are recognized by the database.

2.2 Other Tables

Some other tables are also present in the database application that serve to provide temporary storage or lookup information used during various database processes.

2.2.1 tmptable_Import

Table *tmptable_Import* is used as an intermediate storage table during the data import process. The contents and datatypes of this table are determined dynamically based on user-supplied specifications during the import process. After the data has been transferred permanently to the *Observations* table, this table serves no further purpose.

2.2.2 tblSpeciesInfo

Table *tblSpeciesInfo* stores cumulative temperature threshold values that predict named stages of development during ontogeny of several species of salmonid eggs. The values in this table are used by the Redd Prediction tool which estimates the likely dates for each stage of development based on a redd deposition date, and using observed water temperatures where ever possible (or using historical data or linear interpolation to fill in any gaps in the data sequence).

2.2.3 tmp_Results

Table *tmp_Results* stores a list of egg-development-stage-date predictions calculated for each year of temperature data by the redd prediction model. This permits the minimum and maximum dates to be determined for each stage of egg development when forecasting development stage dates.

2.2.4 tmptable_ReddPredictionSourceData

Table *tmptable_ReddPredictionSourceData* is created during the execution of the redd prediction tool, based on user-input, and serves to provide a temporary static dataset that enables much faster code performance compared to re-querying the raw continuous data multiple times during the execution of the underlying code. At the termination of the redd prediction tool code, this table is deleted from the database application.

3 User Interface

The LCDMS uses a combination of Access database forms and Visual Basic for Applications (VBA) code to enable database users to import continuous data from datalogger files or excel spreadsheets; to export tables and graphs of user-specified summary statistics and control limit values to a Microsoft Excel spreadsheet format; to add and modify control limits, to add and modify locations, to add new parameters, and to perform analysis of temperature data to estimate dates when the various developmental thresholds will be reached for salmonid eggs.

3.1 Main Menu

The main menu form (Figure 3.1) is activated during startup of the LCDMS. This form is the central hub for the user interface and selecting the relevant button on this menu will trigger the major functions of the database. To close the LCDMS completely, the user will select the red *STOP* button at the bottom of the *Main Menu* form. If the user wishes to close the *Main Menu* form but leave the database file open, the *Close Menu* button should be selected instead.

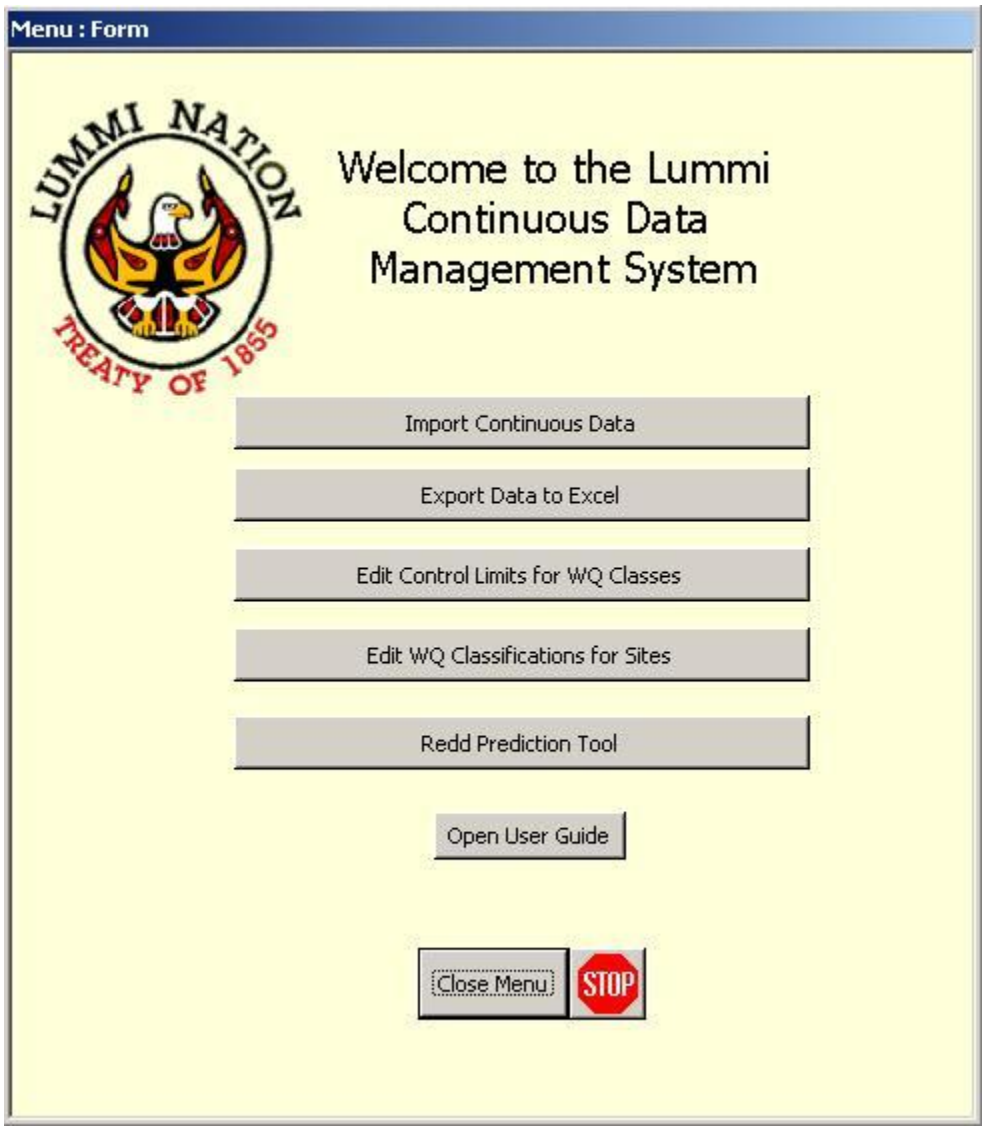


Figure 3.1. The *Main Menu* form opens automatically when the LCDMS is opened

3.2 Importing Data

Before data can be analyzed or exported from the LCDMS the details must be stored within the normalized table structure of the database. However, many files produced by data logger software are stored in a non-normalized arrangement where there are multiple columns of numerical data for each row. In addition, different data loggers may collect data for different arrays of variables. For example, weather stations collect meteorological data but not water quality data, while well data loggers record information about various water-related parameters, but not meteorological parameters. Also, even when the list of parameters is constant, different brands of data logger/sensors may arrange the data differently in their output files, and/or use different units of measurement for the values recorded for the same parameter (e.g., some sensors might record temperature in degrees Fahrenheit instead of degrees Celcius).

To overcome the extreme variability inherent in this situation, a file import tool has been developed. The import tool can be used to import data from files that contain up to a maximum of 12 columns of data. Selecting the *Import Continuous Data* button on the main menu opens the *Import Data* form (Figure 3.2).

Note that during the file import process, the database creates and deletes some temporary tables and queries. This requires that the database be located in a directory where the user has read/write permissions and that the user has exclusive access to the database (i.e., the LCDMS file is not concurrently opened by other users).

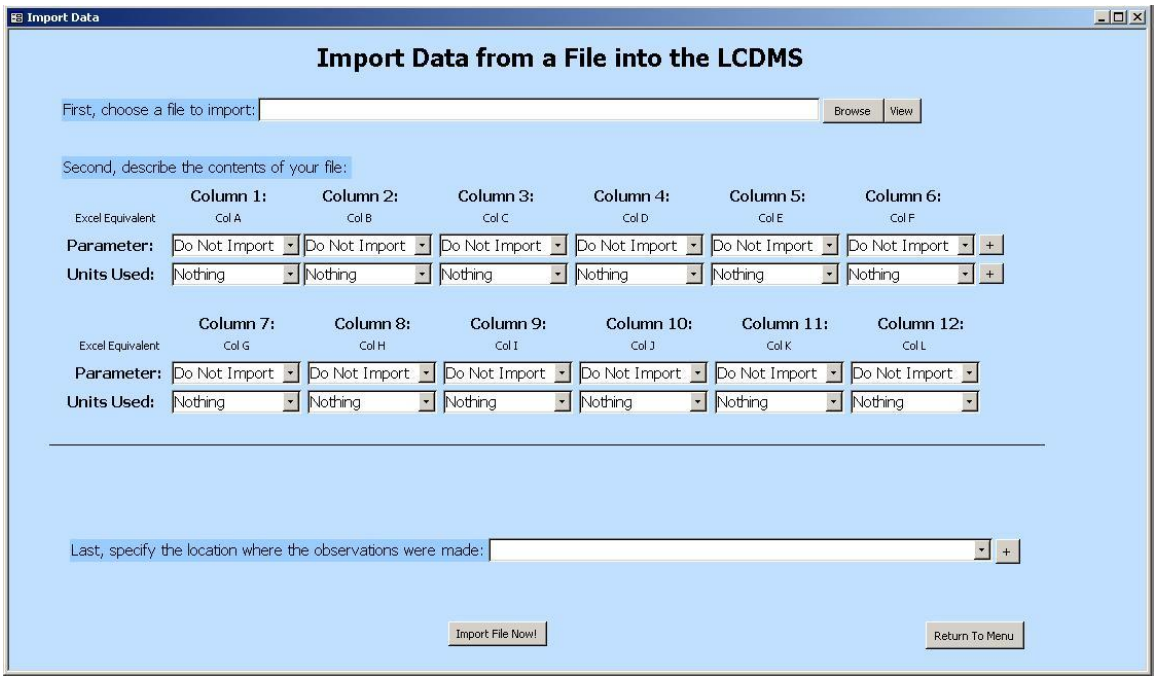


Figure 3.2. The *Import Data* form is used to import continuous data from comma delimited text or xls files

3.2.1 Selecting the File to Import

To begin the import process, the user selects the *Browse* button, which opens the file selection dialog window (Figure 3.3). The dialog window applies a file-type filter that limits selectable files to one of three file formats that can be accepted by the database. The user can navigate to any directory using the standard windows explorer navigation tools, and they can change which of the three file formats to show by using the *Files of Type* drop-down list at the bottom of the window. Once the user has located the file they wish to import they select the *Open* button to continue with the process.

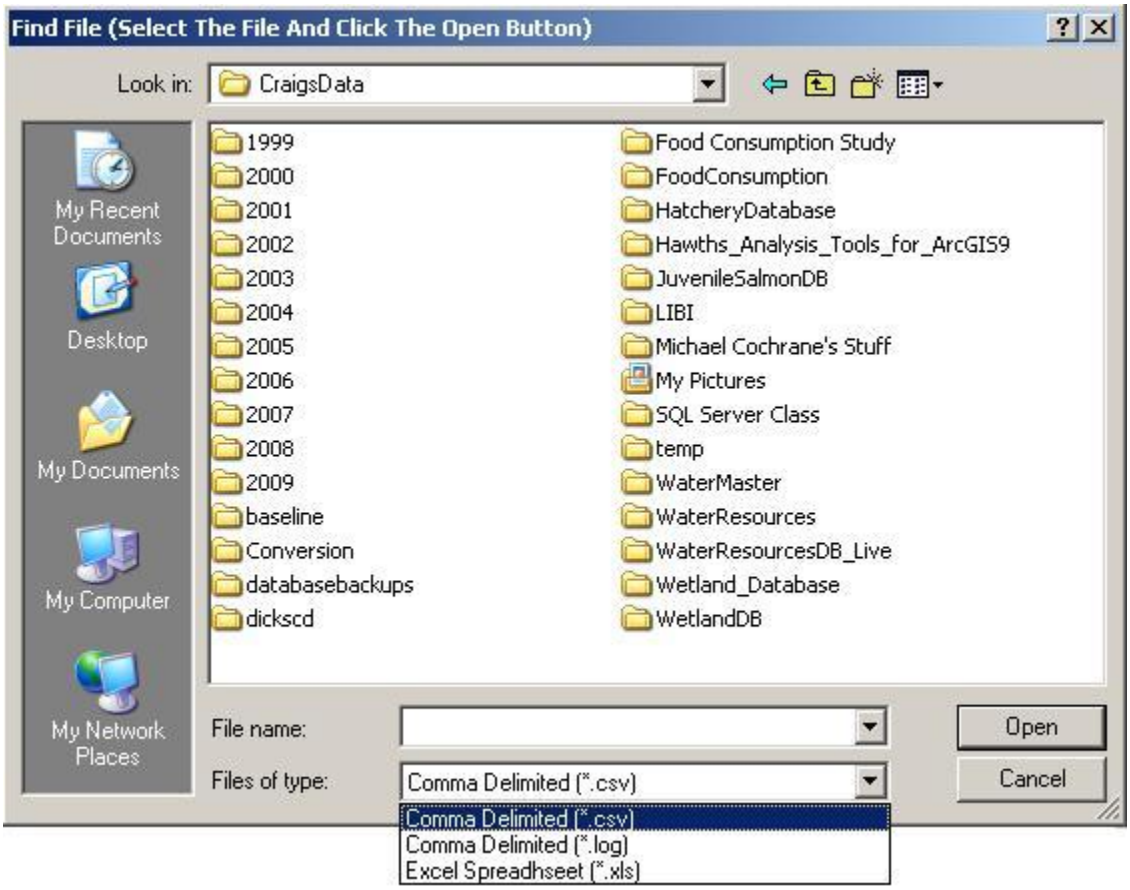


Figure 3.3. The file selection dialog window limits the list of files to formats that can be read by the LCDMS

3.2.2 Specifying the Import File Contents

In order for the database to correctly import the data inside the selected file, the user is required to specify which columns contain data that need to be imported, which parameters are present in each of those columns, and which measurement unit is represented by the values in each column.

To assist with this task, the user can select the *View* button to open the selected file and view the contents. However, the file preview should be closed before selecting the Import File Now button because the LCDMS requires exclusive access to the file during the import process.

3.2.2.1 Adding a New Parameter

If a data column contains useful data but there is no equivalent parameter listed in the *Parameter* drop-down list, the user can add a new parameter to the list by selecting the + button to the far right of the *Parameter* drop-down lists. This opens the *Add New Parameter* form (Figure 3.4). To create a new entry the user must supply a name for the new parameter, and specify a default unit of measurement that will be used for the new parameter, then select the *Done* button.

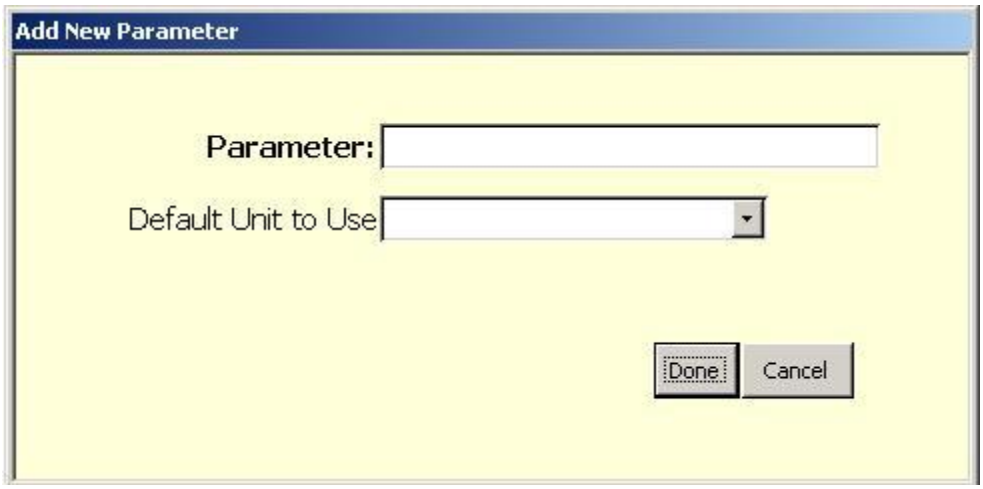


Figure 3.4. The *Add New Parameter* form is used to add new observation types to the LCDMS

Note that, on this form, the user must select units from the existing list. If a new unit is required, the user should cancel out of this form and return to the *Import Data* form, which has the functionality to add new units to the LCDMS. Once the new unit has been added to the database, the user should then repeat the process of adding the new parameter and the new unit should be available for their use.

3.2.2.2 Adding a New Unit

If the values in a column reference a unit of measurement that is not in the *Units Used* drop-down list the user can add a new unit of measurement to the list by selecting the + button that is located to the far right of the *Units Used* drop-down lists. This action opens the *Add New Unit* form (Figure 3.5). The user can then

input the label for the new unit, and select the *Done* button to save the entry and return to the *Import Data* form.

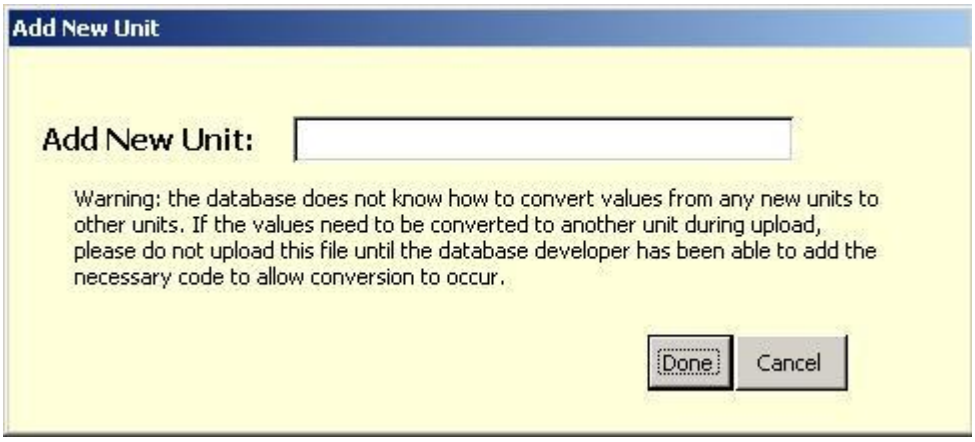
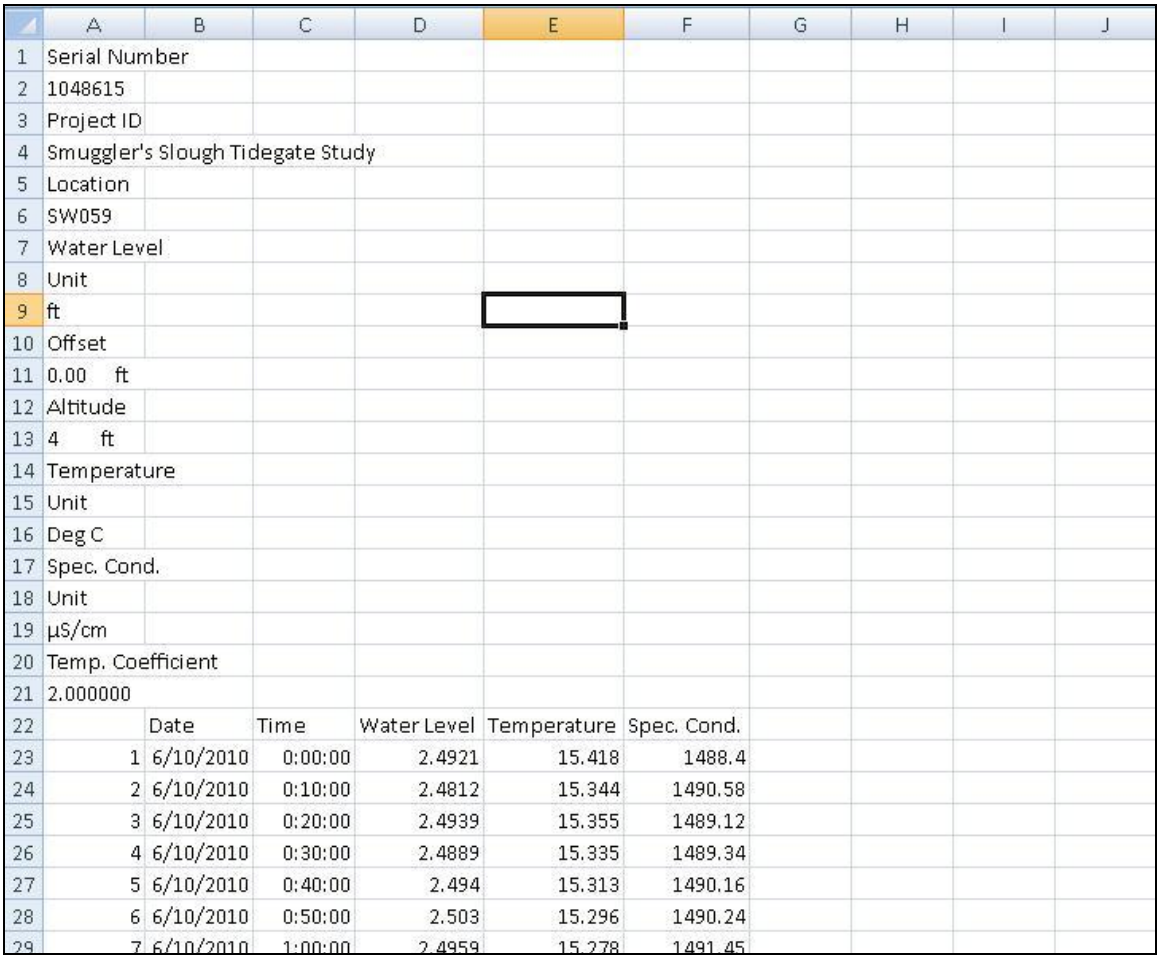


Figure 3.5. The *Add New Unit* form allows the user to add a new unit of measurement to the LCDMS

3.2.2.3 Example File Import Specification

Figure 3.6 shows the first few rows of an example data file produced by a data logger that could be imported into the LCDMS.



	A	B	C	D	E	F	G	H	I	J
1	Serial Number									
2	1048615									
3	Project ID									
4	Smuggler's Slough Tidegate Study									
5	Location									
6	SW059									
7	Water Level									
8	Unit									
9	ft									
10	Offset									
11	0.00 ft									
12	Altitude									
13	4 ft									
14	Temperature									
15	Unit									
16	Deg C									
17	Spec. Cond.									
18	Unit									
19	µS/cm									
20	Temp. Coefficient									
21	2.000000									
22		Date	Time	Water Level	Temperature	Spec. Cond.				
23	1	6/10/2010	0:00:00	2.4921	15.418	1488.4				
24	2	6/10/2010	0:10:00	2.4812	15.344	1490.58				
25	3	6/10/2010	0:20:00	2.4939	15.355	1489.12				
26	4	6/10/2010	0:30:00	2.4889	15.335	1489.34				
27	5	6/10/2010	0:40:00	2.494	15.313	1490.16				
28	6	6/10/2010	0:50:00	2.503	15.296	1490.24				
29	7	6/10/2010	1:00:00	2.4959	15.278	1491.45				

Figure 3.6. A sample CSV file to be imported into the LCDMS, displayed in Excel

This file begins with 21 rows of metadata that are ignored during the import process. The 22nd row contains column header descriptions that are similarly ignored during the import process because different data loggers may use different labels for the same parameter.

The remaining rows in the file contain numerical values in the first six columns.

The first column in this example contains a meaningless row identification number that should be ignored. Accordingly, the user should ensure that 'Do Not Import' is selected in the *Parameter* drop-down list for *Column 1*/*Excel A*.

The second and third columns in the file contain the calendar date and the time at which the values in the remaining columns were recorded. Accordingly, for this

example, the user should ensure that 'Date Only' is the selected parameter for *Column 2/Excel B*, and that 'Time Only' is the selected parameter for *Column 3/Excel C*. However, if the data and time values were combined into one column, then the user would need to select the 'Date/Time' parameter option instead.

Note that both date and time values are required elements for importing continuous data. In the case of average daily temperature data obtained from online sources, only a date may be available. In such a case, the user may elect to also provide a 'Time Only' column indicating the time of day that should be assumed for each observation, or else select the 'Date/Time' parameter option for the column containing only dates. In the latter scenario, the time will be assumed to be midnight at the start of that calendar day.

The final three columns contain values representing Water Level, Water Temperature, and Specific Conductivity respectively. Accordingly, the user should select the matching parameters from the drop-down list for each corresponding column. (For this example, the 'Water Level – Relative' parameter option will be used to import this data).

Caution: '*Water Level*' versus '*Water Level – Relative*' parameter confusion

There are two potential water level options in the drop down list: 'Water Level' and 'Water Level – Relative'. The 'Water Level' option is for values where the absolute elevation of the water surface is to be calculated and compared to a recognized vertical datum, such as Mean Sea Level. The 'Water Level – Relative' option is for water level values that are not corrected to any objective vertical datum and can only be compared to other values from the same source file.
If the user selects the 'Water Level' option, the file import tool will require some additional information to perform the necessary calculations and a new data element will appear on the form (Figure 3.7).

Figure 3.7. Absolute water levels require additional information to be provided to the LCDMS

Because most water level sensors measure pressure and then calculate the depth of water above the sensor, it is necessary to determine the absolute elevation of the sensor in order to determine the absolute elevation of the water surface above it. If the user knows the absolute elevation of the sensor, then they can input this value into the *Vertical Distance* field directly (the measurement units for this value must be in decimal feet or the conversion will be inaccurate). If the user has not calculated this value, a small elevation calculator tool can be opened using the *Calc* button (Figure 3.8). If the user can supply all the supplementary information the calculator will determine the sensor elevation value and input the final value into the import tool.

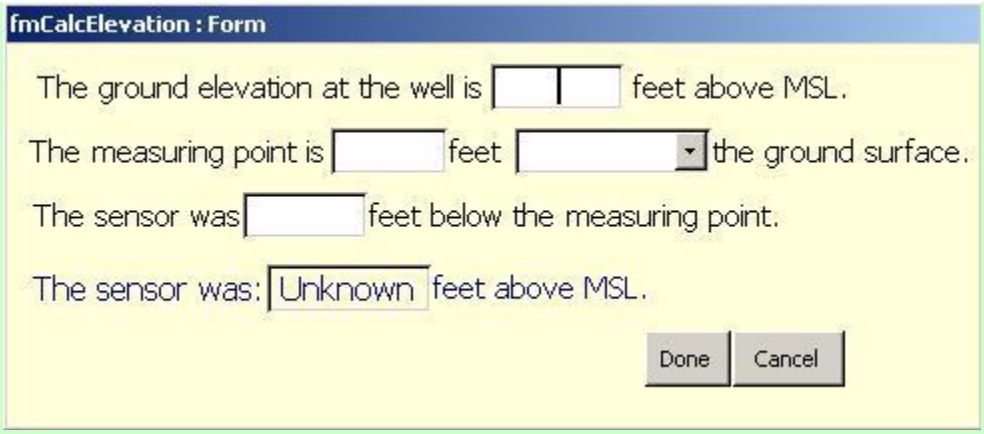


Figure 3.8. The sensor elevation calculation tool

After the user selects the parameter for each column that needs to be imported, a default unit or format for that parameter is shown in the associated *Units Used* drop-down list. If the default formats or units for that parameter do not match the data in the file, then the user should pick the format or unit that accurately matches the data in the file. This allows the database to convert the values to the default units for storage and ensures that all database outputs consistently use the same unit of measurement for each parameter even if various source files use different units. Additionally, the user should note that if any of the cells contain text, or are empty, then the values in those cells would not be imported into the LCDMS.

The remaining columns in the import file do not contain any values and the user should therefore ensure that the parameter drop-down list for any surplus columns is set to 'Do Not Import'. Figure 3.9 shows the completed import specification for the file shown in Figure 3.6.

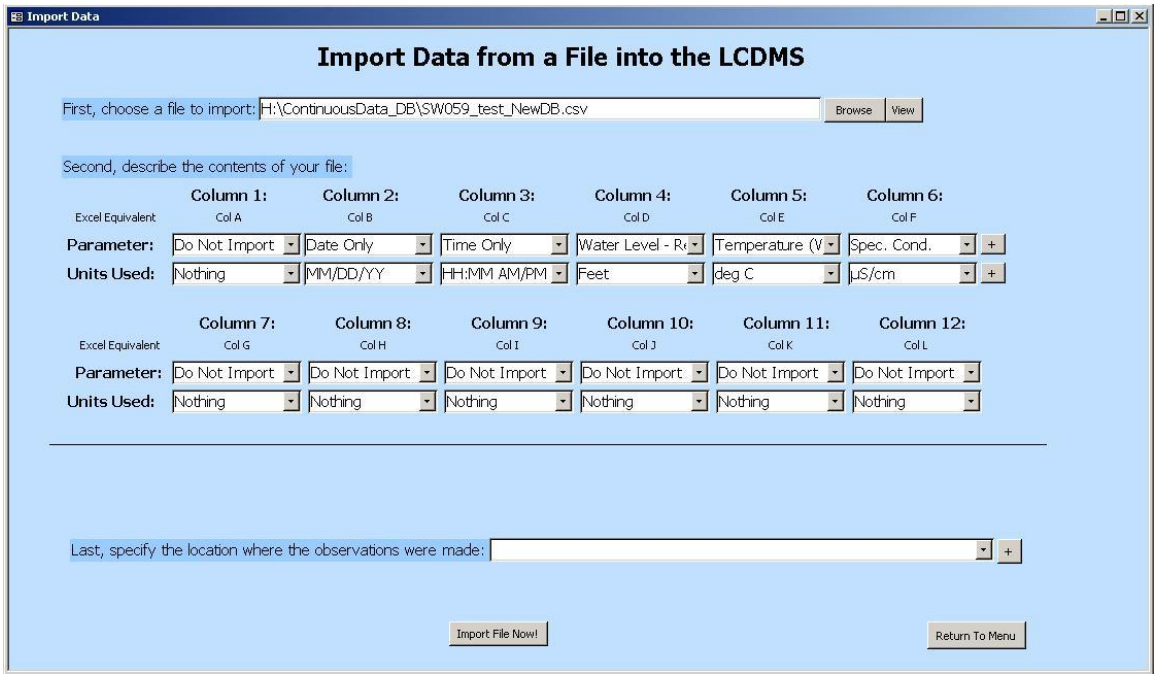


Figure 3.9. The example import file contents, formats, and units have been specified by the user

3.2.3 Specifying the Location

The final step required by the file import tool is for the user to specify the location from which the data in the file was collected in the location drop-down list.

3.2.3.1 Adding New Locations

If the location is not present in the list already, then the user will need to add a new location by selecting the + button that is immediately adjacent to the location drop-down list. Selecting this button opens the *Add New Location* form (Figure 3.10).

To add a new location, the user must input the desired name of the location and select a water quality classification that should be associated with the new location using the drop-down list provided. Once both elements have been entered, the user can save the location and return to the file import tool by selecting the *Done* button.

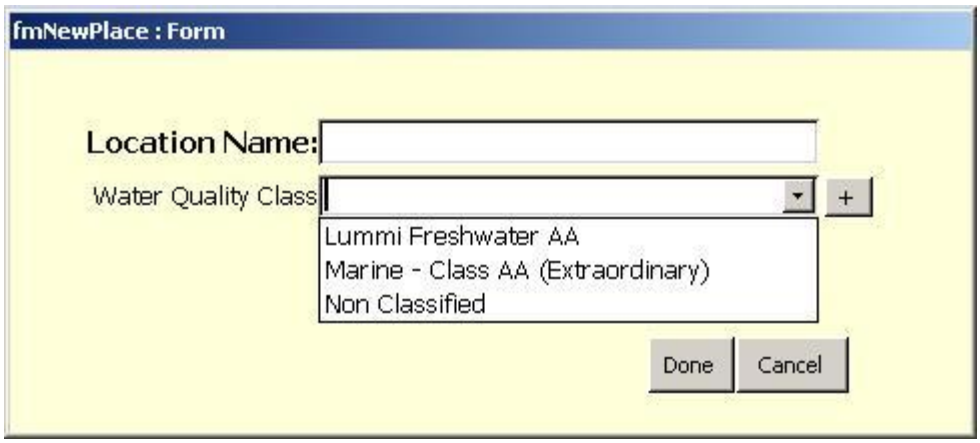


Figure 3.10. The *Add New Location* form is used to add new sites to the LCDMS

3.2.3.2 Adding New Water Quality Classifications

If the user wishes to create a new location that should be associated with a water quality classification that is not already listed, then the user can select the + button adjacent to the WQ classification drop-down list to open the *Add New WQ Classification* form (Figure 3.11).

To add the new classification, the user must specify a classification name in the top field of the form. The user may also optionally choose to add any regulatory water quality control limits and values that are applicable to sites belonging to the new classification. To modify or add WQ classifications at any time, the user can use the relevant editing tool discussed in section 3.5 of this document.

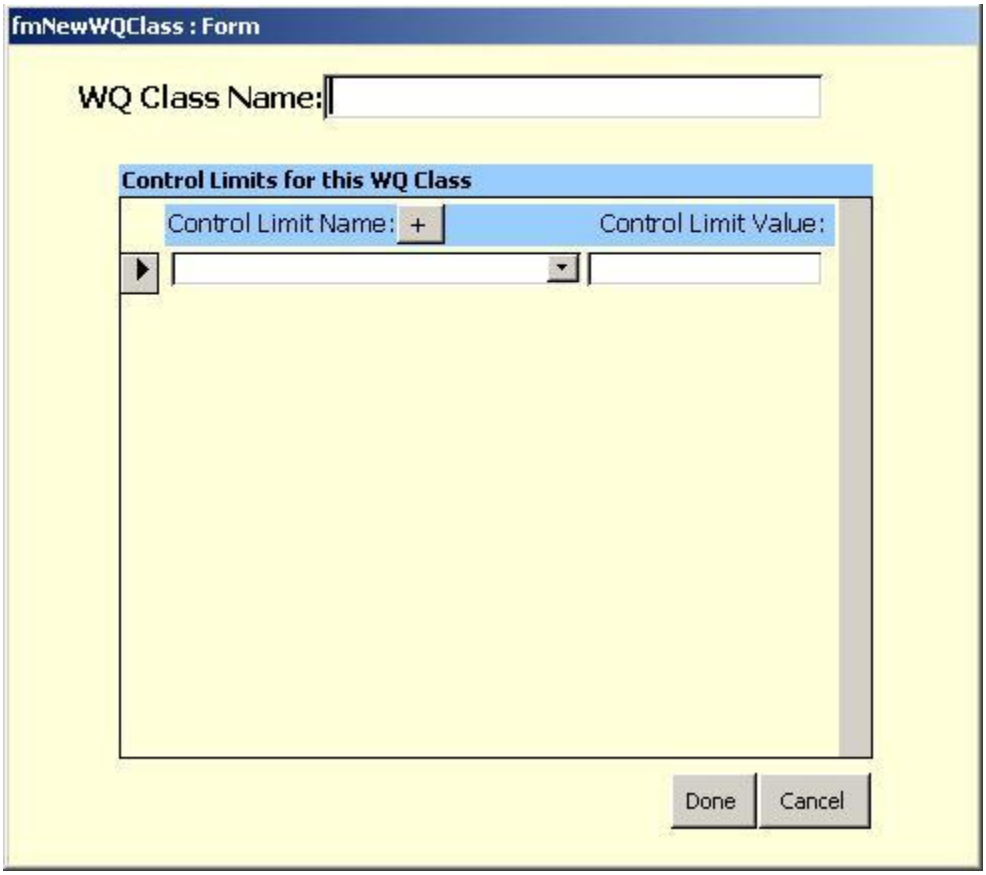


Figure 3.11. The *Add New WQ Classification* form is used to add new sites to the LCDMS

3.2.3.3 Adding New Control Limits

If the user wishes to add a new control limit value for a new water quality classification, they simply select the name of the control limit from the drop down list, and then provide the statutory limit value next to the selected control limit. The user may add multiple control limits for each WQ classification. If the required control limit is not already present in the drop-down list, the user can add a new limit name to the list by selecting the + button, which opens the *Add New Control Limit* form (Figure 3.12).

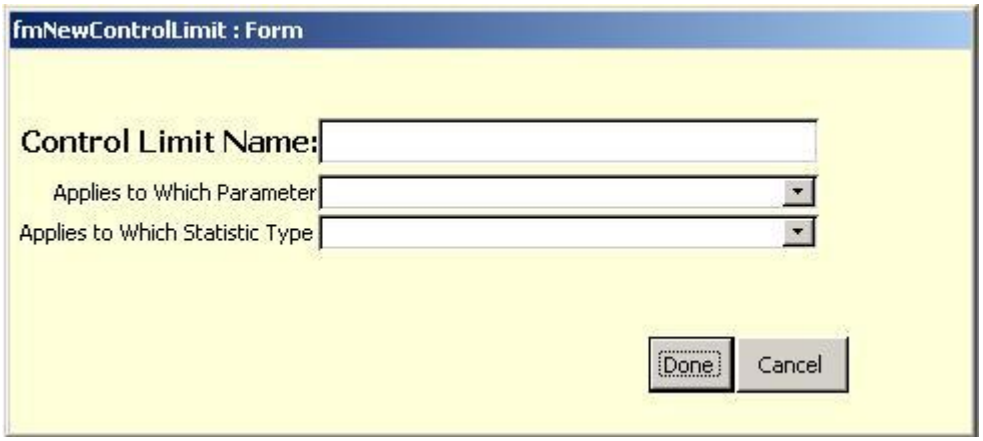


Figure 3.12. The *Add New Control Limits* form is used to add new control limits to the LCDMS

Each control limit is specific to a particular parameter, and a corresponding statistic type must be specified that will be used for comparing the control limit against.

3.2.4 Importing the Data

Once the source file has been selected, the data column specifications have been set, additional requirements have been met (if any), and the location has been identified, then the user can begin the actual data import process by selecting the *Import File Now!* button.

Once the user has selected the button, the LCDMS will attempt to verify that the user has provided all of the required information. Note that the LCDMS has no ability to determine if the specifications supplied by the user are accurate. It is the responsibility of the user to ensure that the column specifications are correct and match up exactly with the column numbers/letters when the source file is viewed in Excel.

Provided that the user has provided all required elements, the LCDMS will begin importing the data to a temporary table with the same de-normalized structure present in the source file.

During the process of transferring data values from the source file to the temporary table, the values are checked to ensure that they exist and are numerical. Null/empty cells, and values in cells that also contain text entries (letters) will not be imported into the temporary table. Any rows that contain nulls/empty cells in the date/time field(s) will be removed from the temporary table and not stored in the LCDMS.

Once the data is located within the temporary table, the values in each of the *Parameter* columns are paired with the relevant date/time value and transferred to the normalized *Observations* table for permanent storage.

As the values are being transferred from the temporary table to the *Observations* table, the units are checked for compatibility with the default units for that parameter. If the units are not compatible, the values in are converted to the default unit of measurement using the custom VBA function *unitconvert*, which is located in the *modFunctions* public module of the LCDMS. Additionally, values for the 'Water Level' parameter are converted from measurements of depth of water above the sensor, to absolute water surface elevations using the user-supplied sensor elevation value that is required for importing this parameter.

Once the data has been successfully imported, the LCDMS will provide a popup dialog box announcing that the import is 'Done'. The file import process may take a couple of minutes, depending on how much data is present in the source file.

Once the user has selected the Ok button in the dialog, they can either select the *Return to Main Menu* button on the *Import Data* form, or else import a new data file by repeating the entire process.

3.3 Exporting Data

The LCDMS provides a data export tool that allows users to extract raw data observations from the stored data, or else to export summary statistic tables and graphs that describe the stored data using time intervals that are specified by the user. To make use of this tool, the user can select the *Export Data* button on the main menu to open the *Export Data* form (Figure 3.13).

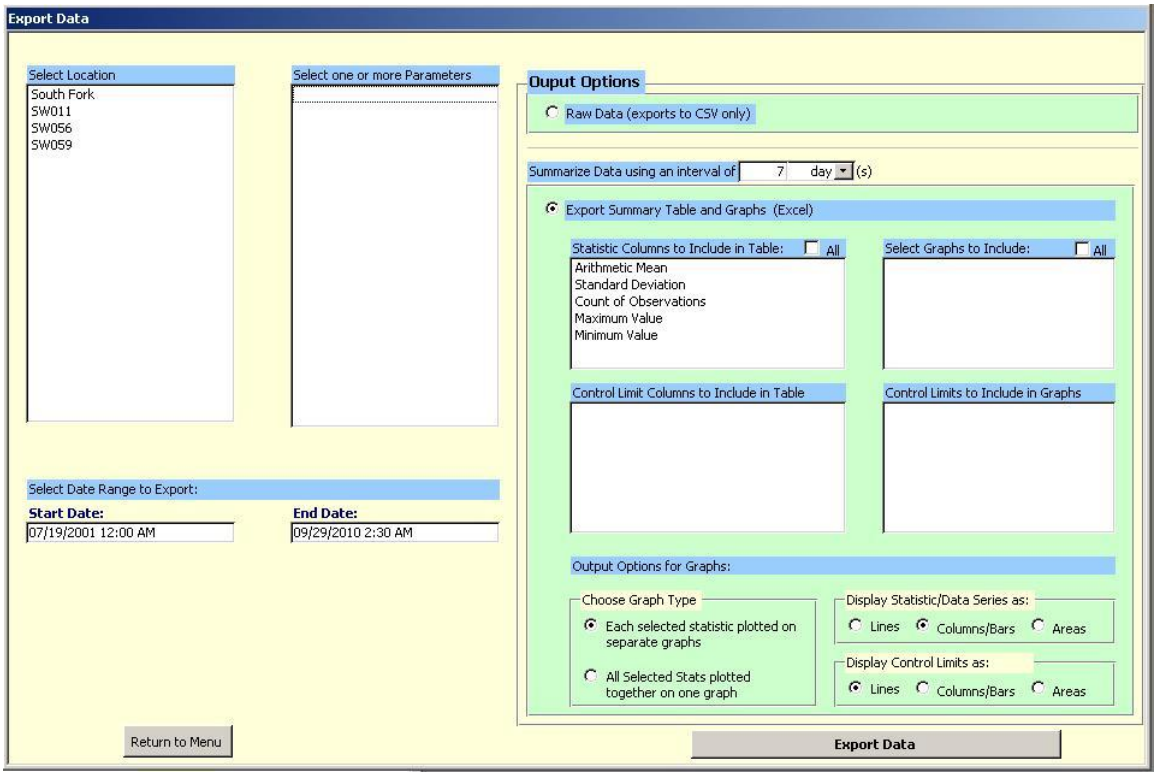


Figure 3.13. The *Export Data* form is used to export data from the LCDMS to other file formats

3.3.1 Choosing Data to Export Using Location, Dates, and Parameters

Before any data can be exported, the user is required to specify the Location from which the data is required. Once the user selects a location, the form will be updated to show the date range for which data is available from that location, and to show the list of parameters for which data are available at that location (e.g., Figure 3.14 shows the location SW059 has been selected for export).

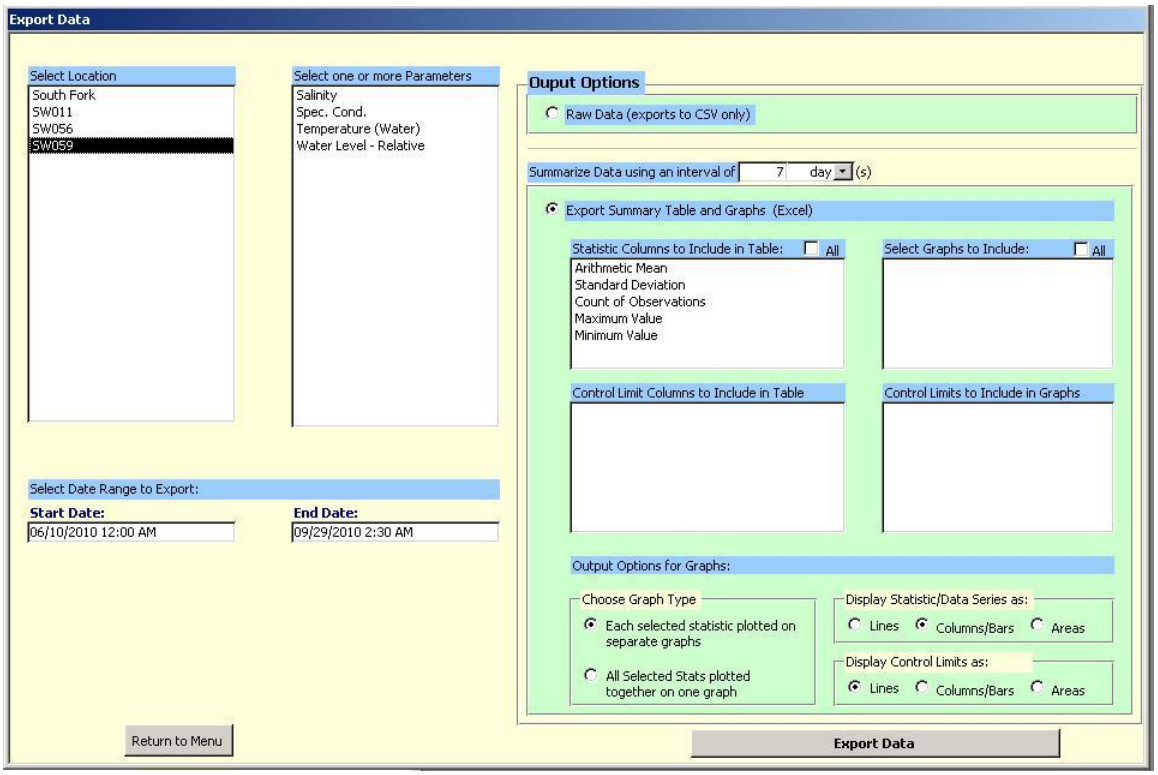


Figure 3.14. The *Export Data* form is updated to show the range of dates and parameters available for the selected location

The user is then required to specify which of the available parameters should be exported, and is also able to narrow down the date range to a subset of the available data if so desired. For example, Figure 3.15 shows three parameters have been selected for export out of the four available from the selected site. The data range has been left unmodified.

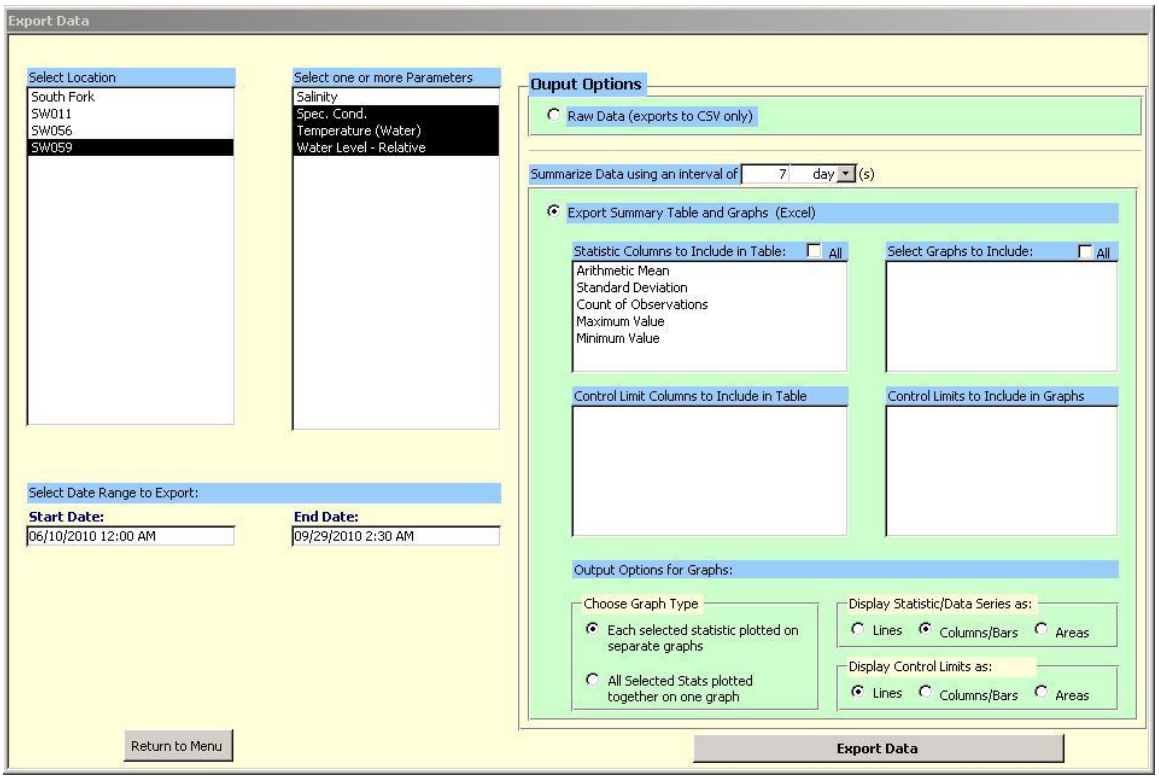


Figure 3.15. Three parameters out of four available from the selected location are selected for export

3.3.2 Choosing the Desired Output Option

Once the location, date range, and parameters have been specified, the user can proceed to specify whether they wish to export 'raw' data (i.e., individual observations with an accompanying timestamp), or whether they wish to export tables and/or graphs of summary statistics for each parameter, using a user-specified time interval to group the raw data.

3.3.2.1 Raw Data Export

To export 'raw data' values from the LCDMS, the user should first select the *Raw Data* option box, and then select the Export Data button to begin the export process. This option creates a comma delimited text file (CSV) that contains the requested data.

The data in the CSV file is de-normalized and contains one row with column descriptions, followed by a row for each date/time when a measurement was recorded at the location. The first column contains the location identifier. The

second column contains the observation date and time. The remaining columns contain the recorded data values; with each column representing a different parameter. The column descriptions indicate the parameter name and units contained in that column.

3.3.2.2 Summary Tables and Graphs Export

The other export option creates an excel spreadsheet file that contains one or more summary statistics of the data for the selected parameters. Additionally, the user may specify that a variety of charts be automatically created in the same file.

Summary Statistic Time Intervals

The LCDMS export function can calculate summary statistics for the requested data using a user-specified time interval. To set the interval the user must provide a numerical frequency and a time unit from the interval drop-down list.

For example, if the user specifies a time interval of '7-days' then the summary statistics will be calculated using data grouped into intervals that each last for 7 days. If the user chooses an interval of '1 month', the summary statistics will be calculated on a monthly basis. Likewise, an interval of '1-Day' would generate summary statistics calculated on a daily basis.

Summary Tables

The export process builds a separate table of summary statistics for each of the selected parameters, and exports them as separate worksheets within the Excel file. Each of these worksheets is named using the corresponding parameter appellation. The tables are comprised of rows that correspond to the user-defined time intervals that were calculated during the selected export date range. The left-most columns provide the location name, the parameter id and name, the interval start date/time, end date/time, and mid-point date/time, and the units of measurement used. One column is then appended for each of the statistics that the user selected from the *Statistic Columns to Include in Table* list ().

	A	B	C	D	E	F	G	H	I	J
1	ObservationPlaceName	ObservationTypeID	ObservationType	FirstObs	MidPeriod	LastObs	Unit	AvgOfObservationValue	MaxOfObservationValue	MinOfObservationValue
2	South Fork	20	Temperature (Water)	7/19/2001	7/25/2001	7/31/2001	deg C	15.43076926	17.20000076	13.5
3	South Fork	20	Temperature (Water)	8/1/2001	8/16/2001	8/31/2001	deg C	15.83548386	18.89999962	11.69999981
4	South Fork	20	Temperature (Water)	9/1/2001	9/15/2001	9/30/2001	deg C	13.05333328	15	10
5	South Fork	20	Temperature (Water)	10/1/2001	10/16/2001	10/31/2001	deg C	7.880645183	11.60000038	5.300000191
6	South Fork	20	Temperature (Water)	11/1/2001	11/15/2001	11/30/2001	deg C	5.943333324	7.900000095	4.099999905
7	South Fork	20	Temperature (Water)	12/1/2001	12/16/2001	12/31/2001	deg C	3.574193543	4.800000191	1.600000024
8	South Fork	20	Temperature (Water)	1/1/2002	1/16/2002	1/31/2002	deg C	3.30322579	5	1
9	South Fork	20	Temperature (Water)	2/1/2002	2/14/2002	2/28/2002	deg C	3.332142881	4.300000191	2.200000048
10	South Fork	20	Temperature (Water)	3/1/2002	3/16/2002	3/31/2002	deg C	3.093548363	5.199999809	0.899999976
11	South Fork	20	Temperature (Water)	4/1/2002	4/15/2002	4/30/2002	deg C	5.331034471	7.699999809	3.799999952
12	South Fork	20	Temperature (Water)	5/1/2002	5/16/2002	5/31/2002	deg C	6.312903189	8.5	4.599999905
13	South Fork	20	Temperature (Water)	6/1/2002	6/15/2002	6/30/2002	deg C	8.626666625	11.10000038	6.400000095
14	South Fork	20	Temperature (Water)	7/1/2002	7/16/2002	7/31/2002	deg C	13.53000005	17.10000038	9.5
15	South Fork	20	Temperature (Water)	8/1/2002	8/16/2002	8/31/2002	deg C	15.73870967	17.70000076	12.39999962
16	South Fork	20	Temperature (Water)	9/1/2002	9/15/2002	9/30/2002	deg C	12.99666659	16.10000038	10.5
17	South Fork	20	Temperature (Water)	10/1/2002	10/16/2002	10/31/2002	deg C	8.593548313	11.39999962	2.700000048
18	South Fork	20	Temperature (Water)	11/1/2002	11/15/2002	11/30/2002	deg C	5.696666654	8.300000191	2
19	South Fork	20	Temperature (Water)	12/1/2002	12/16/2002	12/31/2002	deg C	4.419354823	6.099999905	2.400000095
20	South Fork	20	Temperature (Water)	1/1/2003	1/16/2003	1/31/2003	deg C	4.516128994	6	2.5
21	South Fork	20	Temperature (Water)	2/1/2003	2/14/2003	2/28/2003	deg C	3.69999998	5.300000191	2.099999905
22	South Fork	20	Temperature (Water)	3/1/2003	3/16/2003	3/31/2003	deg C	4.551612885	6.300000191	2.900000095
23	South Fork	20	Temperature (Water)	4/1/2003	4/15/2003	4/30/2003	deg C	6.060000038	8.100000381	4.199999809
24	South Fork	20	Temperature (Water)	5/1/2003	5/16/2003	5/31/2003	deg C	8.348387164	10.39999962	6.300000191
25	South Fork	20	Temperature (Water)	6/1/2003	6/15/2003	6/30/2003	deg C	12.32666664	16.20000076	9
26	South Fork	20	Temperature (Water)	7/1/2003	7/16/2003	7/31/2003	deg C	17.22580654	21	12.80000019
27	South Fork	20	Temperature (Water)	8/1/2003	8/16/2003	8/31/2003	deg C	17.56451613	19.29999924	15.5
28	South Fork	20	Temperature (Water)	9/1/2003	9/15/2003	9/30/2003	deg C	13.99999994	17.39999962	11.10000038
29	South Fork	20	Temperature (Water)	10/1/2003	10/16/2003	10/31/2003	deg C	9.845161346	13.69999981	3.900000095
30	South Fork	20	Temperature (Water)	11/1/2003	11/15/2003	11/30/2003	deg C	4.093333328	5.900000095	1.399999976
31	South Fork	20	Temperature (Water)	12/1/2003	12/16/2003	12/31/2003	deg C	3.822580637	5.400000095	0.800000012
32	South Fork	20	Temperature (Water)	1/1/2004	1/18/2004	1/31/2004	deg C	3.780769197	5.099999905	1.5
33	South Fork	20	Temperature (Water)	2/1/2004	2/15/2004	2/29/2004	deg C	4.120689672	5.5	3
34	South Fork	20	Temperature (Water)	3/1/2004	3/16/2004	3/31/2004	deg C	5.006451607	7	3.599999905
35	South Fork	20	Temperature (Water)	4/1/2004	4/15/2004	4/30/2004	deg C	7.286666679	9.300000191	5
36	South Fork	20	Temperature (Water)	5/1/2004	5/16/2004	5/31/2004	deg C	8.454838691	10.69999981	7.199999809
37	South Fork	20	Temperature (Water)	6/1/2004	6/15/2004	6/30/2004	deg C	11.96999995	15.80000019	8.5

Min_Temperature (Water) | Max_Temperature (Water) | Avg_Temperature (Water) | TemperatureWater

Figure 3.16. Example table output showing three summary statistic data columns for the water temperature parameter at the 'South Fork' location

Finally, if there are any regulatory control limits that apply to the location and the selected parameters/statistics, these will appear beneath in the *Control Limits to Export to Table* list. A column for each selected control limit will be appended to the right of the exported summary table specific to the appropriate parameter.

Summary Statistic Charts

The export tool can automatically generate charts within the Excel file that are based on the exported summary tables. However, it must be noted that the option to export particular charts is unavailable unless the corresponding table data columns have already been selected for export. For example, there is no option to generate a chart showing the arithmetic mean for water temperature unless both the water temperature parameter and the arithmetic mean statistic have been selected for export to the summary table. However, once these have been selected, the 'Arithmetic Mean' option will appear in the *Select Graphs to Include* list and the user may optionally select this option to cause the export process to generate the chart. Similarly, if the user has selected any control limits to be exported to the summary table, these will become available in the *Control*

Limits to Include in Graphs list for addition to the applicable charts that have been selected by the user.

There are also a number of chart formatting options that can be configured by the user prior to export. Once the excel file is created, the user is also free to modify the charts using the standard editing and formatting options that are available within the spreadsheet software.

Graph Types

Graph type determines whether each statistic will be presented on separate charts (Figure 3.17), or whether all of the selected statistics will be presented together on just one chart (Figure 3.18). For example, if there are three selected statistics to be graphed for each selected parameter, the former option will result in three charts per selected parameter, while the later option will result in one chart per selected parameter.

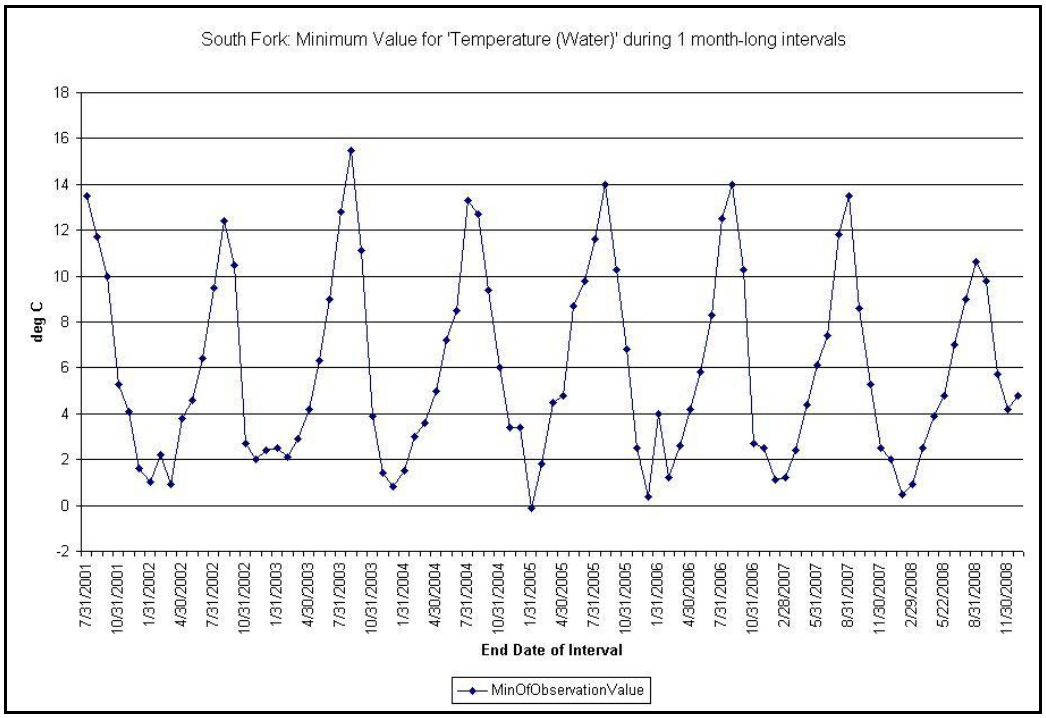


Figure 3.17. Example of a line chart export with only one statistic per chart

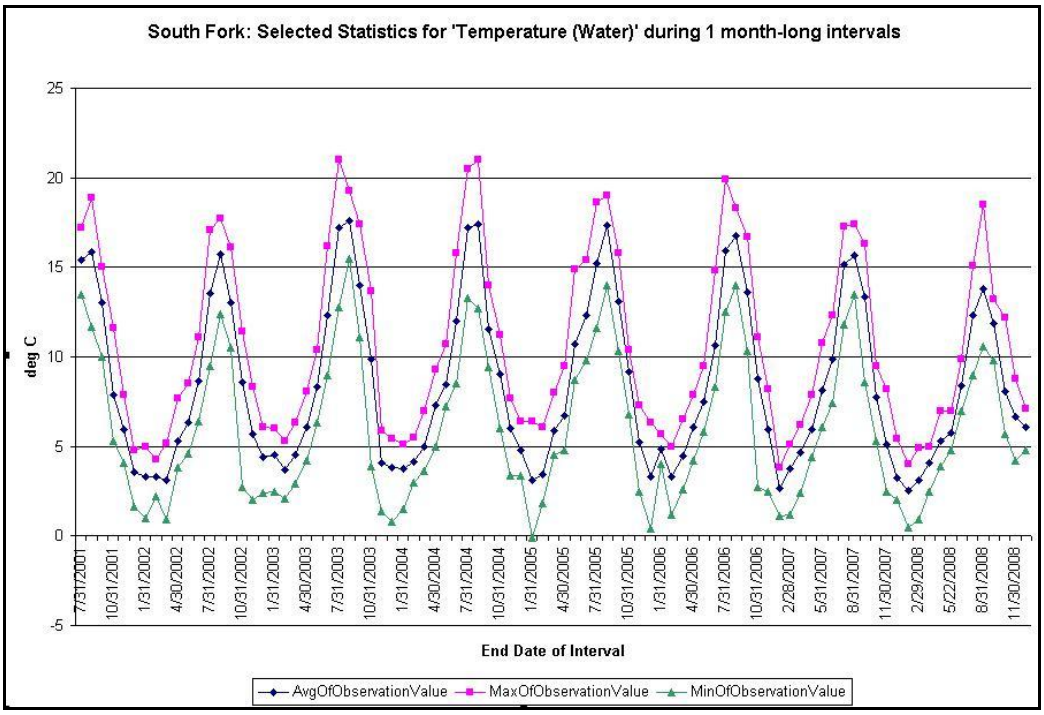


Figure 3.18. Example of a line chart export with multiple statistics on one chart

Summary Statistic Data Series Formats

The export tool allows the user to determine whether the data series that correspond to summary statistics are displayed as lines (e.g., Figure 3.18), columns (e.g., Figure 3.19), or areas (e.g. Figure 3.20). The default setting for data series is to display them as columns.

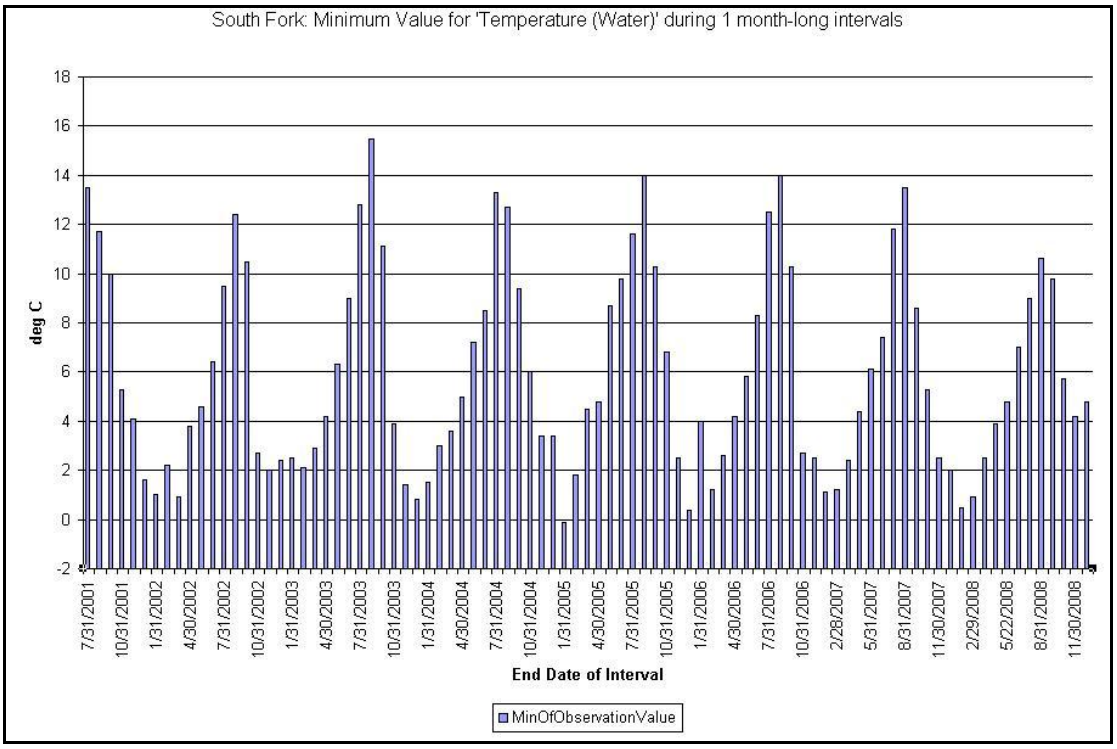


Figure 3.19. Example of a column chart export with one summary statistic data series

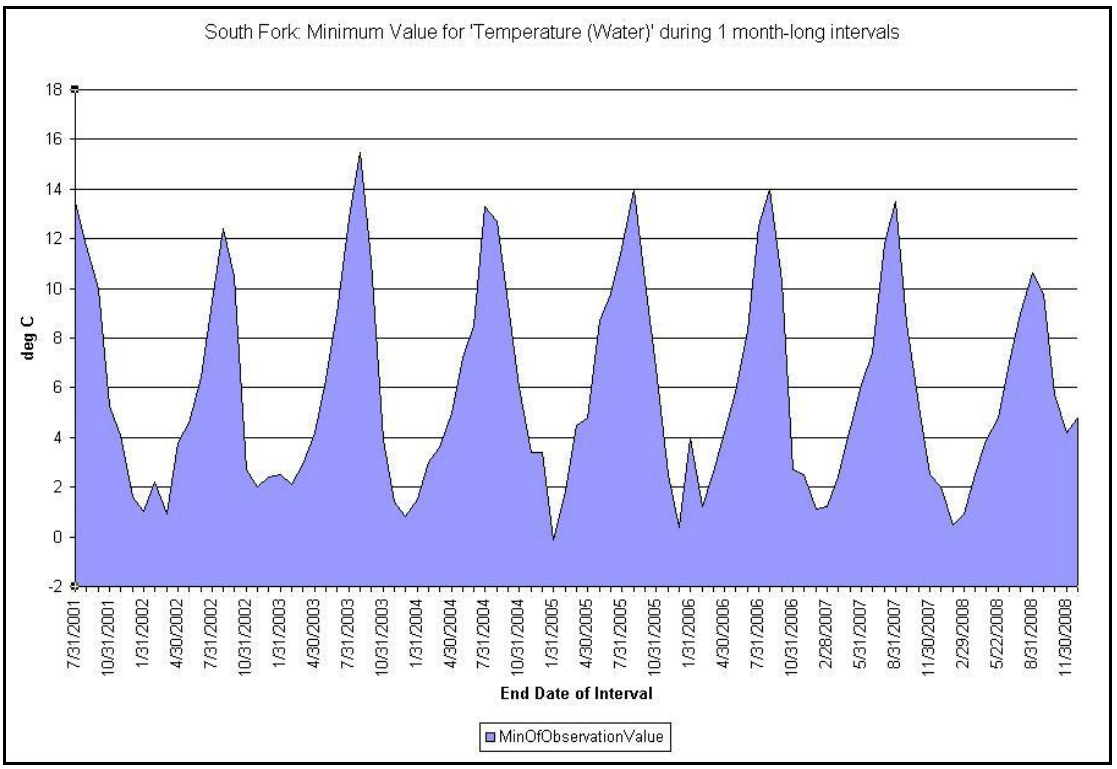


Figure 3.20. Example of an area chart export with one summary statistic data series

Control Limit Data Series Formats

The data export tool allows the user to specify how any selected control limit data series should be displayed on the charts. As with the summary statistic data series, the available options are to display control limits as lines, columns, or areas. The default option is to display control limits as lines.

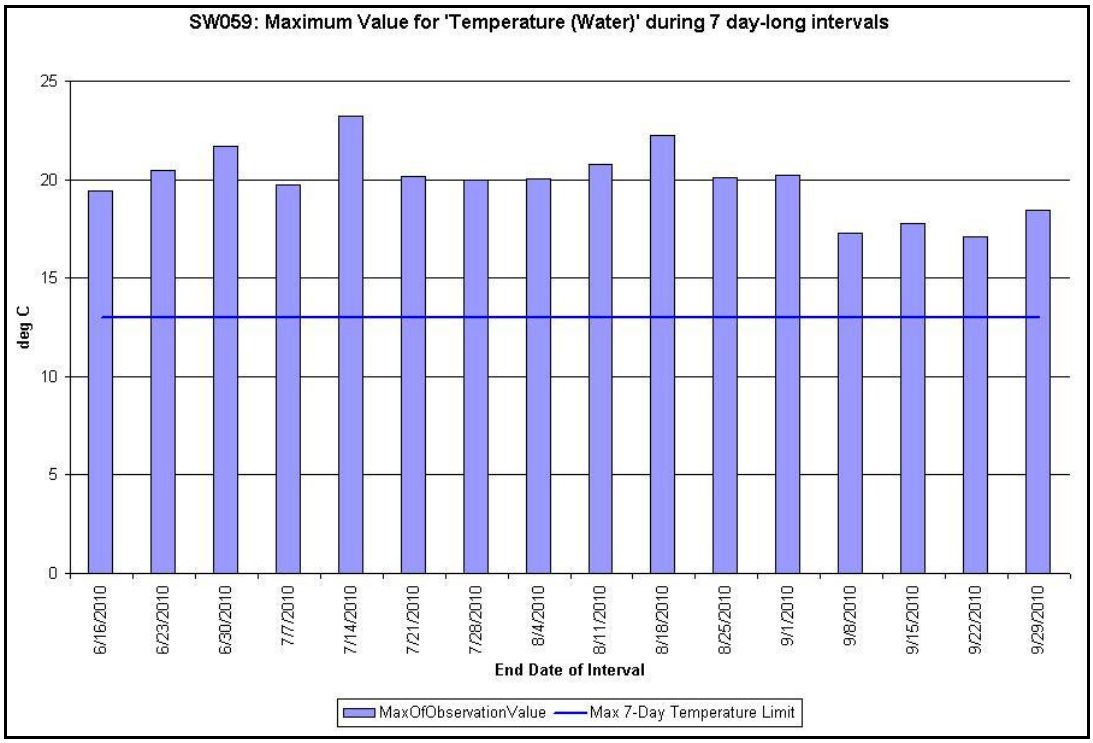


Figure 3.21. The default format for an exported chart uses columns for data series and lines for the control limit series

3.4 Edit Control Limits for WQ Classifications

In the event that the user needs to modify the control limit values for locations with a particular water quality classification, or to add a new control limit entirely, they should select the *Edit Control Limits for WQ Classifications* button on the *Main Menu*. When the *Edit Control Limits* form (Figure 3.22) opens, the user can navigate between the different water quality classifications using the two arrow buttons in the lower left part of the form, and view/modify the control limit values associated with each classification.

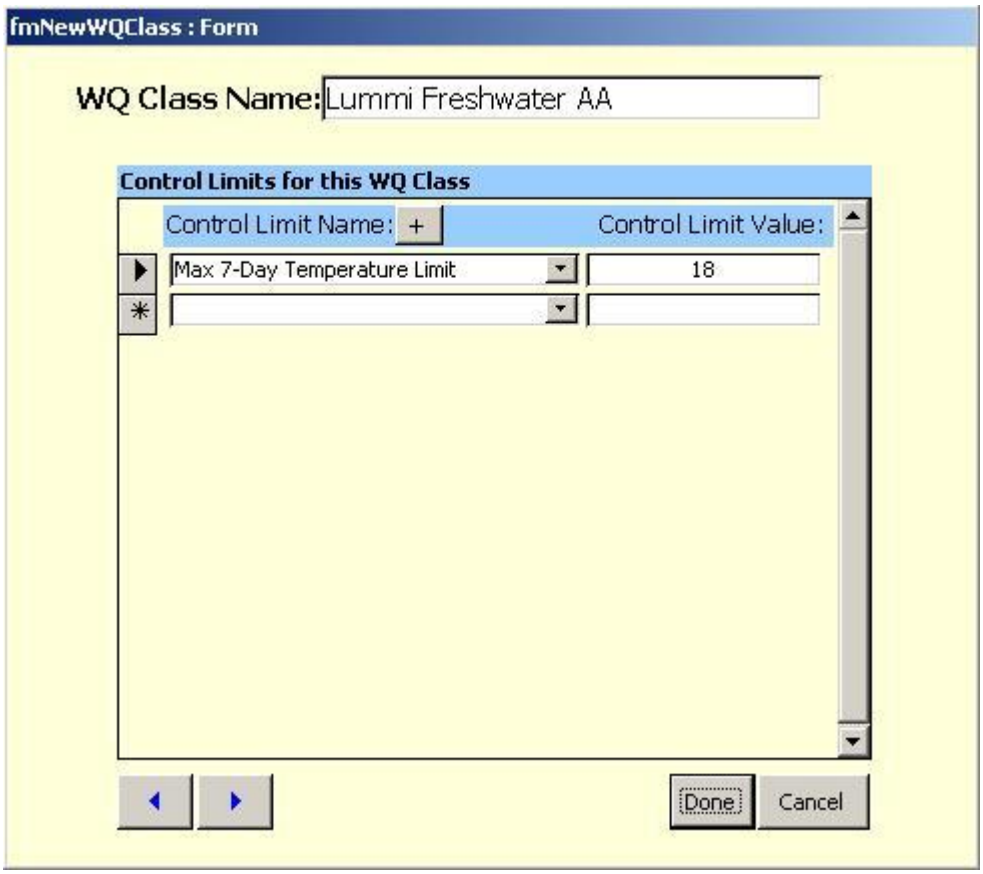


Figure 3.22. The *Edit Control Limits* form is used to add or modify control limits

To delete an existing control limit from a classification, the user can select the row using the row selection button and press the delete key on the keyboard. The user will then be prompted to confirm the deletion.

To add a new control limit to a classification, the user should select the relevant control limit name from the first blank drop-down list, then supply the limit value to be used. If the required control limit name is not present in the list, the user can add a new entry to the list by selecting the + button. This action opens the *Add New Control Limit* form, which is discussed in section 3.2.3.3 of this document.

The user should select the *Done* button to return to the Main Menu.

3.5 Edit WQ Classifications for Sites

To change the water quality classification of a sampling location, the user can select the *Edit WQ Classification for Sites* button on the *Main Menu* to open the *Edit WQ Classifications* form (Figure 3.23).

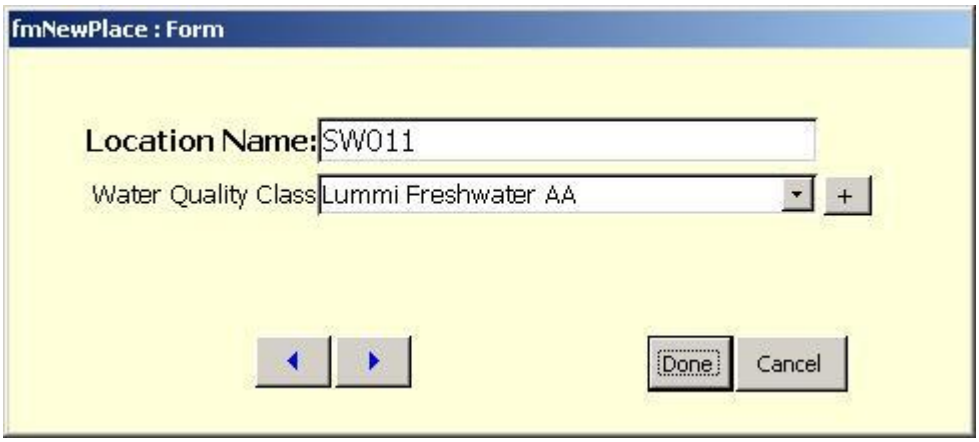


Figure 3.23. The *Edit WQ Classifications* form is used to change the water quality classification for a sampling location

The user can navigate between locations using the blue arrow buttons at the bottom of the form. To change the classification for a location, the user can select the correct classification from the associated drop-down list. If the correct WQ classification is not already present in the list, then a new classification can be added to the list by selecting the + button to open the *Add New WQ Classification* form that is discussed in section 3.2.3.2 of this document.

The user should select the *Done* button to return to the Main Menu.

3.6 Redd Prediction Tool

Selecting the Redd Prediction Tool button on the Main Menu will open the form shown in Figure 3.24.

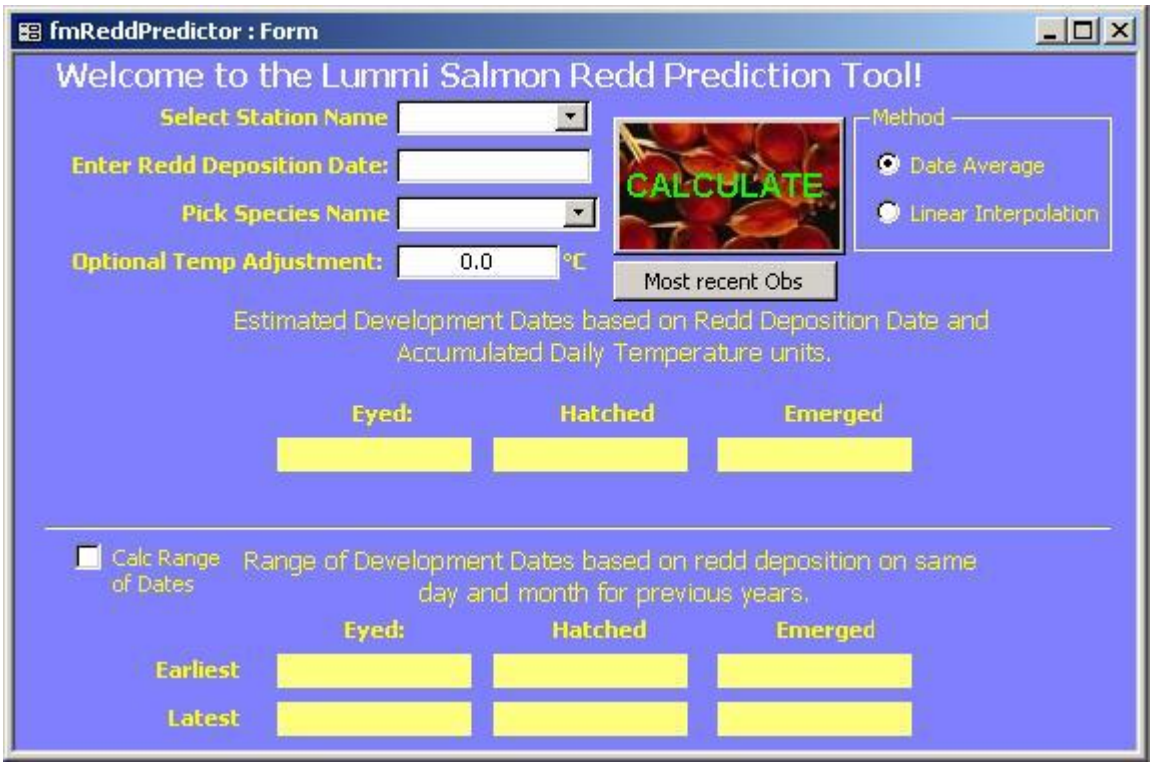


Figure 3.24. The *Redd Prediction Tool* form is used to estimate threshold development dates for salmonid eggs

This form is used to estimate the 'eyed', 'hatched', and 'emerged' dates for salmonid eggs using a species-specific cumulative water temperature model, and a redd deposition date. The cumulative temperature model requires that average daily temperatures be available for all dates during the incubation period. If the model encounters gaps in the sequence, it will estimate the water temperature for those dates using one of two methods. The 'Date Average' method makes use of the available historical data and calculates the average water temperature at the selected location for the same calendar date as the missing data value. The 'Linear Interpolation' method calculates a missing water temperature value using the nearest real temperatures that were measured at the location before and after the missing date. By default, the 'Date Average' method is selected when the form opens. Because this method requires that water temperature data

be available for each day of the year, this will restrict the number of locations available in the drop-down when this method is selected.

To make use of the prediction tool, the user must choose the Method they wish the model to use to fill any data gaps that may be present in the source data. Then the user selects the water temperature location, the redd deposition date, and the species of salmonid. Finally, the user may elect to input an arbitrary temperature adjustment that will be added/subtracted from the measured daily temperature values. Note that once a location has been selected, the user can select the *Most Recent Obs* button to determine when the most recent water temperature observation was taken at that location.

The prediction tool can also be configured to estimate the historical range of threshold development dates by re-running the model for each year of available data and reporting the earliest and latest dates that result from this process. By default this option is not selected because it requires significant additional computing time. To enable this functionality the user can check the *Calc Range of Dates* option.

Once all the input criteria have been entered, the user can run the model by clicking the ‘Calculate’ button.

For example, Figure 3.25 shows the model results using South Fork water temperature data, a Chinook redd deposition date of October 5, 2008, using the ‘Date Average’ method to fill data gaps, with no manual temperature adjustment, and with the *Calc Range of Dates* option checked. When missing dates have been encountered, a pink warning label appears beneath the model output noting that data gaps were present and which method was used to fill them.

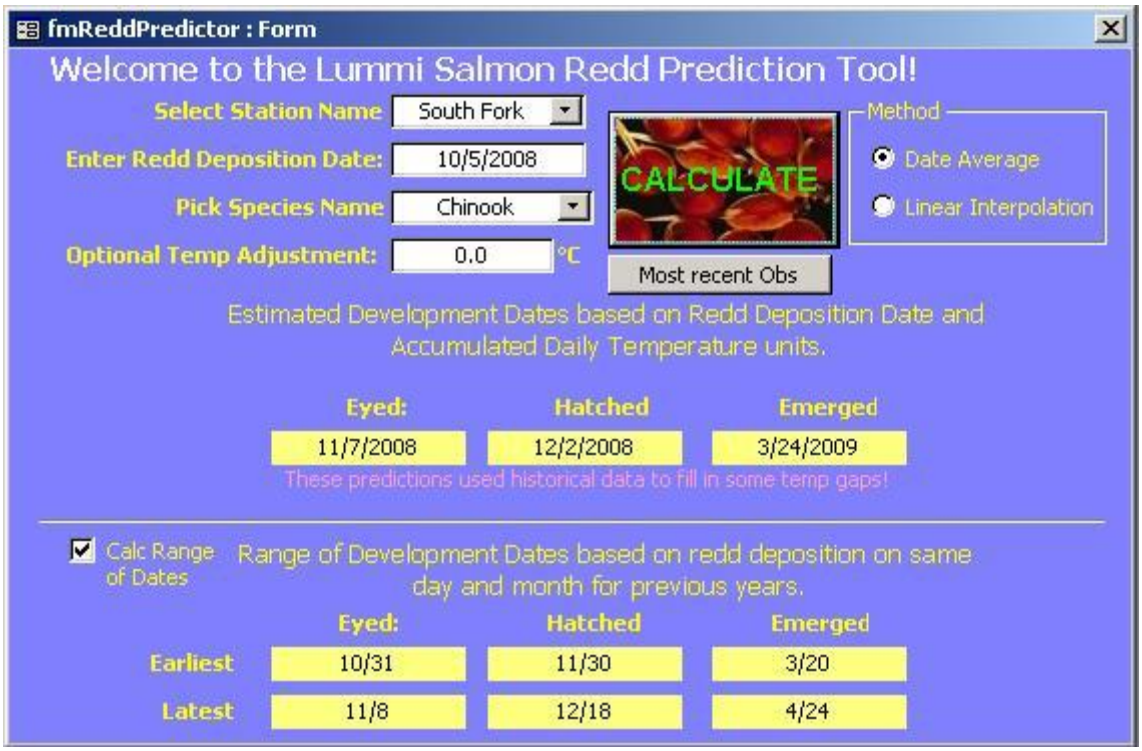


Figure 3.25. Example results from the redd prediction tool

To return to the Main Menu, the user clicks the x button at the top right corner of the form.

3.7 Open User Guide

The user can open the most recent version of this document by selecting the *Open User Guide* button from the Main Menu.